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Disseminated and vein amphiboles in Kapfenstein lithospheric mantle (Austria)

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A series of amphibole-bearing ultramafic xenoliths from basaltic tuffs of Kapfenstein (Graz Basin, Austria) have been investigated in order to highlight the relationships between the genesis of amphibole and metasomatic event/s that affected the lithospheric mantle under Graz Basin. The magmatic activity in this area took place as part of the Plio-Pleistocene extension-related alkali basalt volcanism which occurred in the Carpatho-Pannonian region, post dating the calc-alkaline volcanism which formed the inner Carpathian arc. Samples are mainly protogranular to porphyroclastic spinel lherzolites, with only one harzburgite in the whole suite. Pargasitic amphibole is present in the majority of samples, mostly as disseminated crystals and, in one case, as a large vein (up to 1cm wide). Texturally, amphibole occurs as disseminated crystals (Amph-D), surrounding spinel and/or closely intermixed with clinopyroxene, or in vein cutting the primary peridotitic assemblage (Amph-V)(Coltorti et al., 2004). All minerals are well equilibrated and glass is present only in small amounts (in contact with disseminated amphiboles). Basalt infiltration is totally absent but in the harzburgite, where a dark glass vein with small secondary crystals penetrates the peridotitic matrix. Apart from mantle xenoliths, amphibole is also found as megacrystals, whose origin can be related to the alkaline magmatic activity responsible for the nodule ascent. Amph-D have similar major element compositions, but in chondrite normalized trace element spidergrams they distribute in two distinct groups. The first, named Type1, is characterized by enrichments in LREE, Ba, Sr and expecially Nb [$(La/Yb)_N$ varies from 3.10 to 6.26]; HREE are flat between 5 and 8 X chondrite. The second, Type2, has a depleted pattern [$(La/Yb)_N$ = 0.12-1.2] with extremely low Nb content, positive anomaly in Ti and flat HREE at 12 X chondrite. With respect to Amph-D, Amph-V are characterized by higher TiO_2, K_2O, FeO, and lower Al_2O_3, Na_2O and Cr_2O_3

contents. They are enriched in Ba, Nb, Ta, Sr and LREE [$(La/Yb)_N$ goes from 5.4 to 6.1] with a noticeable Zr negative anomaly, the highest Ti values and fractionated HREE pattern. Their major and trace element composition is very similar to that of amphibole megacrystals found in the eruptive tuffs. Clinopyroxenes associated with Amph-D present an homogeneous and fertile composition with high Al_2O_3 contents (up to 7wt%) and TiO_2 always lower than 0.8 wt%. They are characterized by flat to slightly enriched LREE [$(La/Yb)_N$ = 0.93-5.56], HREE at 10 X chondrite, high Th and U contents and remarkable Sr and Ti negative anomalies. Their most noticeable characteristic is the ubiquitous (even though variable) Zr and Hf positive anomalies, which, as far as author's knowledge, is uncommon in mantle diopside. Clinopyroxenes of anhydrous xenoliths share similar patterns with cpx of amphibole-bearing nodules, but on the whole they have highest Th, U, Zr and Hf contents.

This could testify a previous, anhydrous metasomatic event that affected the lithosphere under Graz Basin before amphibole generation. Clinopyroxene patterns of the veined sample are on the contrary completely different: they do not record the anhydrous metasomatism; they appear only affected by different degrees of partial melting. Their $(La/Yb)_N$ ranges from 0.21 to 0.51, and they show marked Zr, Hf and Ti negative anomalies.

Different genetic mechanisms are envisaged for Amph-D and Amph-V. Both Type1- and Type2- Amph-D grow at the expense of cpx through a metasomatic reaction with percolating fluids, while Amph-V are crystallization products from a basic magma similar to the host basalt which precipitated the megacrystals, intersecting the lithosphere trough discrete fractures at shallow depth.

Thermobarometric estimates, determined by Brey & Kohler (1990) and Kohler & Brey (1990) geothermobarometers in fact suggest that Amph-D-bearing samples come from deeper portions of the lithospheric mantle (45-56 km), whereas the sample with Amph-V records a depth of about 33 km.